

## Diaphyseal Nutrient Foramina in Human Femur

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**Abstract:** The major blood supply to the long bones occurs through the nutrient arteries, which enter through the nutrient foramina. This blood supply is essential during the growing period of bones. Knowledge regarding the nutrient foramina of bones is useful in surgical procedures to preserve circulation. The study was conducted to analyze the numbers and location of nutrient foramina on diaphysis of 85 numbers of human dry femur collected from the Department of Anatomy, Regional Institute of Medical Sciences, Imphal, Manipur. The nutrient foramina location and number/s were identified macroscopically. Single nutrient foramina on the diaphysis of femur was more frequent (71.8%), followed by double nutrient foramina (24.7%) and absent foramina (3.5%). Distribution of foramina is more on linea aspera (90.3%), 5.9% & 3.8% were found on medial and lateral surfaces respectively. Most of the nutrient foramina were present on the upper third of the intermediate area on linea aspera and double nutrient foramina were found on upper third and lower third as well as in between intermediate and medial lips. This study provides data on the morphology of diaphyseal nutrient foramina in human femur which in turn will give information to preserve circulation during surgeries.

**Keywords:** Diaphysis, Femur, Linea Aspera, Nutrient Foramina.

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### I. Introduction

Nutrient foramen is an opening into the bone shaft which gives passage of the blood vessels to the medullary cavity of a bone. Diaphyseal nutrient arteries enter the shaft obliquely through the nutrient foramina leading to nutrient canal.<sup>1</sup> The nutrient canal which is initially horizontal gets slanted during the growth. The direction of slant is due to the difference in the growing rates of the both sides of epiphysis.<sup>2</sup> The direction of slant from surface to marrow cavity points towards the end that had grown least rapidly.<sup>1</sup> The nutrient artery is the principal source of blood to a long bone particularly during its active growth period, supplies both osteal tissue as well as bone marrow.<sup>1,2</sup> The diaphysis of femur is irrigated by one or more nutrient arteries which divide in the medullary cavity into ascending and descending branches while accompanied by the terminal branches of numerous metaphyseal, epiphyseal arteries.<sup>3</sup>

The principal nutrient foramen (NF) of the femur is located towards the middle of the linea aspera (LA) with a possible numbers and variations in position.<sup>1</sup> This foramen in the majority of cases is located away from the growing end.<sup>4</sup> Though the direction of the foramina are away from the actively growing end, their topography might vary at the non-growing end. So, the topographical anatomy of nutrient foramina may be of worth.<sup>5</sup> Very few studies has been done on the nutrient foramina morphology over linea aspera. So, the present study is aimed to analyze number, locations and direction of nutrient foramen in diaphysis and linea aspera of adult human femur.

### II. Materials & Methods

The present study was done on 85 cleaned, dry human adult human femurs, collected from the undergraduate students of Department Of Anatomy, Regional Institute of Medical Sciences, Imphal. The formal permission from the concerned authority had been taken prior to the study. In all the bones, after determining the side, were examined macroscopically. The location and the number of the diaphyseal nutrient foramina on diaphysis of the each of bone were identified by the presence of a well marked, often slightly raised edge at the commencement of the canal. The number and the topography of foramina in relation to specific borders, surfaces or linea aspera of the diaphysis were analyzed. The direction of the foramina was noted. The foramina within 1 mm from any border were taken to be lying on that border. The measurement of linea aspera was taken at the commencement of divergent point of the two lips above and down by a sliding caliper. The linea aspera was divided into three equal parts by sliding caliper- an upper 1/3, a middle 1/3 and a lower 1/3.

For the bones which have double nutrient foramina, the larger foramen was taken into consideration as dominant or primary foramen. A 24 Gauge needle was passed through each foramen to confirm the patency. Foramina smaller than a size of 24 Gauge needle were not taken in consideration in this study. After noting all the details of foramen, results were tabulated and compared with previous workers.

III. Results

Table 1: Diaphyseal nutrient foramina distribution in femur, (% = percentage).

No of foramen	Femur					
	Right		Left		Total	
	No	%	No	%	No	%
0	1	2.4	2	4.6	3	3.5
1	31	73.8	30	69.8	61	71.8
2	10	23.8	11	25.6	21	24.7
Total	42	100	43	100	85	100

The direction of all the foramina was towards the upper end of femur. 90.30% of the foramina were found on linea aspera, 5.90%, 3.80% were over medial and lateral surfaces respectively.

Table 2: Distribution of total foramina on linea aspera, (% = percentage).

Area of distribution	Distribution of foramen on linea aspera				
	Upper 1/3	Middle 1/3	Lower 1/3	Total	%
Medial lip (ML)	10	7	17	34	36.6
Intermediate lip (INT)	39	5	11	55	59.1
Lateral lip (LL)	0	3	1	4	4.3
Total	49	15	29	93	100
Percentage (%)	52.7	16.1	31.2	100	X

Single nutrient foramina distribution on linea aspera showed that, 62.30% foramina were over intermediate area, 32% on medial lip, whereas only 5.7% were found on lateral lip. When linea aspera was divided into three equal parts, the foramina were found the highest in upper one third (58.50%), followed by, lower third (24.50%) and middle third (17.0%).

The distribution of double nutrient foramina on diaphysis of femur were found the highest on upper and lower third (67.70%), followed by upper & middle third (19.0%) and middle & lower third (14.30%). The double nutrient foramina on linea aspera were mostly found on intermediate & medial lips (55.0%), followed by intermediate & intermediate lips (25.0%), medial & medial lips (15.0%) and intermediate & lateral lips (5.0%).

IV. Discussion

The observation of the present study shows that no femur with more than two nutrient foramina was found. The majority (71.8%) of the femur had a single nutrient foramina followed by double nutrient foramina (24.7%) and absent foramina (3.5%) was also observed by the study of Kizilkanat E et al.<sup>6</sup> where 75% of the femur had single and 25% had double nutrient foramina but no cases was observed with absent foramina and also was found by Collipal E et al.<sup>7</sup> and Mysorekar VR.<sup>5</sup> In present study, majority of both the right and left sided femur had single nutrient foramina followed by double nutrient foramina which is not similar with the observation of Collipal E et al.<sup>7</sup> where double nutrient foramina were more than single on right side and with equal prevalence on left side.

Table 3: Review of other workers with present study, (% = percentage).

Nutrient Foramina (NF)	Morphology	Present study (%)	Prasanth KU et al (%)	Collipal E et al (%)	Kumar R et al. (%)	Al-Motabagani MAH (%)	Kizilka-nat E et al (%)	Bhatnagar S et al. (%)	Ojaswini et al (%)	Pereira GAM et al (%)	Kumar S et al (%)
Number of femur with NF	Single	71.8	47.7	44	-	48.5	75	55	-	63.8	59.5
	Double	24.7	44.2	52	-	48.5	25	43.33	-	34.9	33.3
	Absent	3.5	4.6	-	-	3	-	1.67	-	-	-
Location of NF on diaphysis	Linea aspera	93.3	76.7	72.5	57.33	-	44	-	-	93.4	-
	Medial surface	5.9	18.6	21.25	5.33	-	39.2	-	-	-	-
	Lateral surface	3.8	1.2	6.25	5.33	-	16	-	-	-	-
Location of NF on linea aspera	Medial lip	36.6	56	27.5	18.66	-	-	-	88.6	-	-
	Intermediate area	59.1	36.4	36.25	27.33	-	-	-	-	-	-
	Lateral lip	4.3	7.6	8.75	11.33	-	-	-	6.5	-	-

All the nutrient foramina were directed towards the upper end of femur, also were found by Pereira GAM et al.<sup>8</sup> and Al-Motabagani MAH.<sup>9</sup> In present study double foramina present were not in equal size were also noticed by Al-Motabagani MAH.<sup>8</sup> Collipal E et al.<sup>9</sup> stated that, the nutrient foramina were restricted on linea aspera or adjacent area. Similar was stated by Kizilkanat E et al.<sup>6</sup> and Kumar S<sup>10</sup> that majority of the foramina were present on linea aspera with some foramina on the medial surface adjacent to linea aspera also was found in present study with some foramina on the lateral surface adjacent to linea aspera. Kumar S et al.<sup>10</sup>

found single nutrient foramina on upper third and middle third of linea aspera were 48% & 32% respectively. In present study, the nutrient foramina on upper third were found higher (58.5%) and lower in middle third (17%).

### **V. Conclusion**

The observations of the present study on the nutrient foramina incidence and distribution on femur indicates that they were predominant on the upper one third of intermediate area on linea aspera and double nutrient foramina were found on upper third and lower third as well as in between intermediate area and medial lip of linea aspera. Exact location and distribution of the nutrient foramina is important to avoid damage to the nutrient vessels and to preserve circulation during various surgical procedures.

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